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I N D E X

		Page
FOREWORD & REVIEW		1
NEW ZEALAND		5
CHILE		9
PRICES & TRENDS		18
UNITED STATES SULPHUR		22
JEFFERSON LAKE SULPHUR COMPANY		26
SURVEY OF SULPHURIC ACID IN U.S.A.		29
SULPHUR IN ITALY		32
OIL AS A SOURCE OF SULPHUR		33
UNITED KINGDOM SULPHUR		37
CURRENT EVENTS		42
U.K.	- Exit Gas Purification Plant	42
Australia	- Potential Source of By-product sulphur	42
	Addenda (Bulletin No.3)	43
Canada	- New Sulphur Recovery Plant	44
U.S.A.	- Freeport Sulphur Company	44
	Standard Sulphur Company	45
	New Sulphur Recovery Plant	46
	Offshore Sulphur	46
	Sulphur Deficiency in Soils	47
W. Germany	- Gas Desulphurisation	48
Italy	- Phosphatic Fertiliser Plant	48
Sweden	- Sulphuric Acid from Smelter gases	49
	Recovered Sulphur	49
U.S.S.R.	- Research into Sulphur & Sulphuric Acid Production from Coal Pyrites & Anhydrite	50
Turkey	- New Developments	51
Iraq	- Texas Gulf Sulphur Company	52
Mexico	- Texas International Sulphur Company	53
	Mexican Gulf Sulphur Company	54
Cuba	- New Pyrites Production	54
Trinidad	- Sulphur Recovery Plant	54
Brazil	- Sulphur Recovery from Coal Pyrites	55
Japan	- Refining of Low Grade Ores	56
STATISTICAL APPENDIX		57

F O R E W O R D

This number of the Quarterly Bulletin is the first to be supplemented by an Airmail Edition. The long time taken by surface mail to distant overseas countries has, for some time, given us anxiety knowing that these delays might cause inconvenience to some of our subscribers, and detract from the usefulness to them of the information published in Bulletins and Newsletters. It is hoped that this arrangement will enhance the value of the Bulletin as a world-wide medium of sulphur information.

March, 1954.

R E V I E W

NEW ZEALAND, the Commonwealth country reviewed in this Bulletin, is wholly dependent on imports for its sulphur requirements. The size of the sulphur industry is practically determined by the fertiliser industry, which, because of phosphorus deficiency in the farming land, is of vital importance to the country's predominantly agricultural economy. Sulphur consumption in 1953 amounted to about 76,000 tons, and after 1954 it is expected that requirements will be 90,000-100,000 tons per annum brimstone, for sulphuric acid manufacture. In considering new projects the disadvantages of using alternatives to brimstone are being weighed against the uncertainty of long-term supplies. The use of Australia' pyrites concentrates is receiving serious consideration for at least one project, and processes for the production of phosphatic fertiliser not requiring the use of sulphur are also envisaged. The ultimate usage of fertiliser is expected to reach an equivalent of $2\frac{1}{2}$ million tons per annum super-phosphate, about three times the current production, and as the country's well-being may depend on the solution of the sulphur supply problem, it assumes greater importance than the actual extent of sulphur requirements may imply.

The sulphur industry of CHILE holds a prominent place in world sulphur affairs, more on account of its

large reserves than the output. Primitive mining methods and low refining efficiency are accentuated by adverse climatic conditions obtaining at the great altitudes at which deposits are situated, and by transport difficulties. As the country's domestic requirements are at present only about 17,000 tons per annum, the sulphur industry's expansion must depend on its ability to export, but high production costs making Chile a marginal producer have prevented this in the past two years, with the result that the output in 1953 was less than one-third of the installed production capacity of 120,000 tons per annum. By granting the industry special facilities, permitting sulphur export sales at competitive world prices, the Government are at present trying to encourage production. The long-term solution of the question is indicated by some enterprising companies who are installing modern plants and planning rational production, although the full exploitation of the country's vast resources may require the stimulus of foreign interests.

In the UNITED STATES production of native and recovered sulphur during 1953 was about 50,000 tons (0.9%) less than during 1952, as the increase of recovered sulphur production of about 90,000 tons was insufficient to make up for the reduction of native sulphur production of about 140,000 tons during the year. At the same time, apparent domestic consumption rose 8% to 4,256,000 tons, while 1953 exports at 1,241,536 tons declined 5% compared with 1952. During the current year new production from two domes of Freeport Sulphur Company and one dome operated by Standard Sulphur Company, is expected to provide an additional sulphur tonnage of 600,000 tons, and although the decline of output at some existing domes may amount to $\frac{1}{4}$ million tons and new sulphur using capacity is expected to raise consumption by 200,000-300,000 tons, the U.S. industry should be in a position to build up stocks to about nine months' domestic consumption, thus reversing the trend of declining stock which has been causing anxiety in recent years to Administration and producers.

The JEFFERSON LAKE SULPHUR COMPANY, the third largest sulphur producer in the world is extending its field of operation to the production of sulphur by recovery from sour gas. From autumn, 1954, the new plant at Worland, Wyoming, will add annually about 40,000 tons to the company's Frash sulphur output which, in 1953, amounted to 375,883 tons, $7\frac{1}{2}$% less than during the preceding year.

+ of 5,492,000 tons

The survey by the Business and Defence Services Administration of the U.S. sulphuric acid industry, which is one of the dominating factors in world sulphur affairs, contains salient data of its size and activities during the years 1950-52. Total acid output by commercial producers in 1952 of 12.3 million tons acid, which absorbed inter alia 3.1 million tons brimstone, is estimated to have risen 7% during 1953, thus increasing the industry's call on brimstone by a further 200,000 tons.

In ITALY further efforts are being made to place the industry on a sounder footing. Production during 1953, amounting to 227,750 metric tons raw melted sulphur was the highest on record since the war, but as exports were negligible, unsold stocks accumulated. This trend continued during the early part of this year when it was accentuated by a reduction of domestic consumption, and the stockpile is now estimated to contain about ¼ million tons sulphur.

Although the production of sulphur by recovery from OIL REFINERY GASES makes an important contribution to world sulphur supplies, it appears that greater use could be made of this source, subject, of course, to the ruling technical and economic limitations of oil refining practice. It is estimated that currently, treatment of oil refinery gas throughout the world results in about 150,000 tons sulphur being recovered.

In the UNITED KINGDOM consumption of sulphur in all forms in 1953 amounted to 755,000 tons, the highest on record and about 25% greater than in 1952. Although consumption of brimstone totalling 347,600 tons for "regular" and "acid" use increased, the proportion used in sulphuric acid manufacture dropped to 38¾%, compared with 43% in 1952. The completion of three-quarters of the new pyrites burning plants scheduled under the 1951 conversion programme, raised pyrites consumption to 378,100 tons during the year, and to an annual rate of nearly ½ million tons during December.

Sulphuric acid production during 1953 amounted to 1,875,200 tons, the highest on record. The high rate of sulphur consumption, of which only 57% were met by imports and 7% by indigenous production, resulted in a further reduction of stocks to a level, as forecast,+ of barely two months' requirements.

+ See Bulletin No.3.

The increasing sulphuric acid requirements during the current year may entail consumption of brimstone at a higher rate than anticipated, and on present indication this may not be much lower than during 1953, in spite of the increasing arisings of pyrites acid, and the additional acid supplies which will become available after August, 1954, when the extension to Imperial Chemical Industries Ltd.'s anhydrite plant at Billingham is expected to be completed.

There has been virtually no change in world sulphur prices since U.S. sulphur producers put their new prices into effect on 1st January, 1954. As the result of new Frasch sulphur production becoming available in the U.S.A. the world supply position is at present easy. Whereas during 1953 world production of native and recovered sulphur did not suffice to meet requirements, and a reduction of stocks occurred, this trend is expected to be reversed during the current year although, towards the end of 1954, a tighter supply position may again manifest itself. Beyond this, the greatest single factor is thought to be the outcome of Mexican Frasch sulphur projects.

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N E W Z E A L A N D

General

Despite the volcanic origin of the islands and the continued existence of much volcanic activity, there are today no commercially exploitable deposits of native sulphur. A comprehensive survey in 1940 of the Rotorua district, where intensive solfatara and fumarole activity occurs, revealed the presence of about 15,000 tons of sulphur in the form of flows and sublimations, and in the area north of Lake Taupe, some 3,000-4,000 tons sulphur in the form of 30-60% sulphur rock were found. Sulphur deposits on White Island which, in view of intermittent exploitation from 1885-1929 yielding some 10,000 tons of sulphur, it was hoped might commercially exploitable, were found to be much less extensive than expected and working conditions, due to gas emanations and other volcanic activity, were found to be so dangerous that work had to be permanently abandoned.

Although present in widely disseminated form in old rocks, there are no commercial deposits of metal sulphides, and the known deposits of gypsum are neither of sufficiently high quality nor accessible enough to permit the economic use for sulphuric acid manufacture. The only source that might, at some future date, contribute to the country's sulphur needs, given the development of an economic recovery process, are the substantial arising of hydrogen sulphide gas from geysers and fumaroles.

The sulphur industry of New Zealand is virtually identical with the country's fertiliser industry. This is wholly based on consumption of brimstone for acid manufacture, and its requirements are met by imports. The fertiliser industry is of vital importance to the New Zealand economy due to the latter's predominantly agricultural nature. What is more, practically the whole of the farming land is naturally deficient in phosphorus, and super-phosphate and its derivatives account for more than 80% of the total fertiliser usage.

Consumption

With the exception of an annual tonnage of 2,000-3,000 tons distributed over a variety of industrial uses, the entire consumption of sulphur in New Zealand is converted into sulphuric acid for super-phosphate manufacture. The following graph shows sulphur consumption by the fertiliser industry over the period 1939-1953:

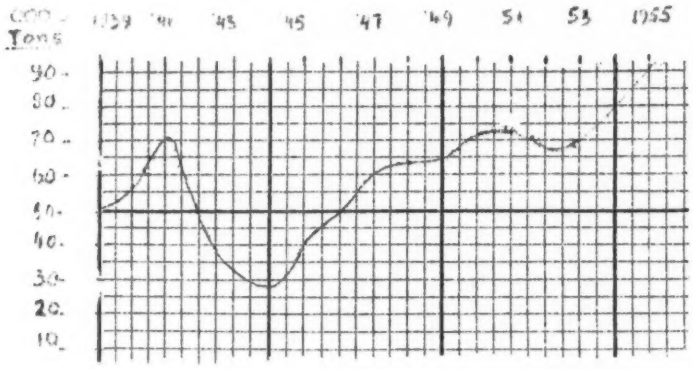


TABLE I

Apart from about 12,000 tons imported from Japan in 1952, and negligible tonnages intermittently procured from the U.K. and Australia, all sulphur imports+ originate from the U.S.A. During 1953 New Zealand received some 94,000 tons of sulphur, which, with shipments in transit, brought total receipts during last year to over 100,000 tons. Of this tonnage, about 24,000 tons are intended as additions to a stockpile which, in view of anticipated purchases in 1954 of 109,000 tons exceeding requirements by a similar amount as in 1953, will reach 11 months' supply by the end of the year.

There are at present four companies operating eight fertiliser works - located at Auckland, Christchurch and Dunedin - each producing their own sulphuric acid requirements. Their combined plant capacity is about 240,000 tons per annum acid (100% H_2SO_4), or about 750,000 tons super-phosphate. The acid plants

+ For details see Statistical Appendix.

all built between 1920 and 1930, are chamber type installations producing weak (50-60°Bé) acid for super-phosphate manufacture. For this, phosphate rock is imported from Nauru and Ocean Islands, which, in view of its richness permits the production of 20.5% P_2O_5 super phosphate.

The above eight plants are not well sited from the point of view of economic distribution of fertilisers, and the future trend is to erect new plants rather than to extend existing capacities. Of the new fertiliser plant projects at Invercargill on South Island, and Napier, Whangerei and Tauranga on North Island, only ~~the last named~~ Napier will come into production this year. This plant will have an annual production capacity of 120,000 tons super-phosphate, and consume about 14,000 tons per annum sulphur. The New Zealand Government's participation in this project represents an important departure from present practice under which all existing fertiliser works are wholly controlled by private enterprise. It had become apparent, in the case of the Napier project, that, although the farming development of the district was being retarded by the lack of fertiliser supplies, there was not enough farmer investment capital available to cover plant erection costs. The Government then participated by taking up shares roughly corresponding to the areas of crownland in the district, and the New Zealand Meat Producers' Board invested a very substantial sum by way of loan on debenture shares at a low rate of interest.

The Napier project was decided upon before the world sulphur crisis and before the restrictions on sulphur usage, and so it is entitled to participate in any available sulphur supplies in case of a recurring shortage. The same provision does not apply to any other new projects, and each of the groups interested, comprising mainly farmers, will have to decide on what type of plant they wish to erect. If the Government and Meat Board are satisfied as to the proposals, it is expected that they would assist financially as in the case of the Napier project.

The uncertainty of future brimstone supplies has awakened considerable interest in the fused calcium-magnesium phosphate process for which all

the raw materials are available locally - except, of course, phosphate rock - and pilot plant production by the Department of Scientific and Industrial Research is undergoing field tests.

The groups promoting the Whangerei and Tauranga projects are understood to favour the production of super-phosphate, and were it not for the uncertainty of future supplies these plants would be based on sulphur. At present, serious consideration is being given to a pyrites burning plant, notwithstanding its higher capital and operating costs, which would be alimented by Australian pyrites. In this connexion, Mount Morgan pyrites concentrates appear to be the most economical material.

Beyond these proposed new works already at the investigation stage, there is some prospect of establishing in the more remote future a triple super phosphate plant utilising the electric furnace system.

Summarising the above, it appears that, after 1954, New Zealand sulpur requirements will be at the rate of 90,000-95,000 tons per annum, rising perhaps to 100,000 tons as the result of maximum employment of and possible minor extensions to existing plants. New super-phosphate plants to be erected are expected to have an annual capacity of 100,000 tons, thus adding about 12,000 tons per plant to the country's annual sulphur requirements.

Trade and Prices

All sulphur purchasing arrangements are in the hands of the British Phosphate Commissioners, who also procure the sulphur requirements of Australia. The landed cost in New Zealand of sulphur during 1953 is estimated at about £16 per ton. This represents a substantial reduction over the previous two years when, due to higher freight costs and the purchasing of some sulphur of other than U.S. origin, landed costs were as high as £18.

As regards pyrites, it is understood that Mount Morgan concentrates may become available at a price of under £4 f.o.b. Gladstone, which would result in a price at works (New Zealand) of about £17 per ton of sulphur in pyrites.

Conclusion

The lack of indigenous sulphurous raw materials, together with the country's essential need of phosphatic fertilisers, preferably in the form of super-phosphate, places New Zealand in a unique position in the light of today's world sulphur situation.

Of the country's total area of 66 million acres, 43 million are "occupied lands", of which today only 18 million acres are grassland and about 2 million acres carry field crops, etc., with little more than one-third of this area receiving fertiliser application. The Department of Agriculture believes that, when all available farmlands are fully developed, fertiliser usage will reach an equivalent of $2\frac{1}{2}$ million tons per annum super-phosphate which, if acid-based, demands the use of 220,000-240,000 tons sulphur in one form or another.

Already, the uncertainty of future American sulphur supplies has forced the promoters of new projects to investigate other sources of sulphur - notably Australian pyrites concentrates - or other methods of producing phosphatic fertilisers not requiring the use of sulphur. The dependence of the agricultural economy of New Zealand on increasing phosphatic fertiliser usage makes it of the utmost importance to ensure economic brimstone supplies. The alternatives are, at best, an expensive substitute that may seriously affect the country's economy.

C H I L E

General

The sulphur deposits of Chile are amongst the largest known reserves of native sulphur in the world today. Situated on the volcanic peaks of the Chilean Andes they extend in an almost unbroken chain for about 600 miles from north to south from Tacora to Copiapo, and more scattered still further towards the southern tip of Chile. Most deposits are found at altitudes between 12,000 and 14,000 feet, but some in the north are as high as 20,000 feet, whereas some lesser deposits in the south are encountered at much lower altitude (5,000-10,000 feet).

Although by far the largest number of the Andean sulphur deposits are in Chile, several extend across the frontier into Peru, Bolivia and the Argentine. Historically, sulphur has been exploited in Chile since the middle of the seventeenth century, and up till modern times it was almost exclusively used in the manufacture of black gunpowder, at first for military, and later, in the nineteenth century, for industrial use, mainly by the nitrate mining industry.

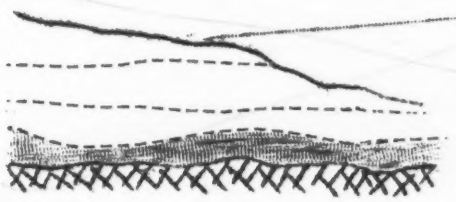
The increasing use of sulphur in agriculture, the chemical and explosive industry, and, in recent years, in the manufacture of rayon, has brought about some slight expansion of the industry, but, being unable to gain a foothold in export markets, it has never attained the size that its potential resources warrant. The high cost occasioned by mining and transport difficulties, and the uneconomic refining methods cause Chile to remain a marginal producer. Currently the industry has a potential capacity of about 120,000 tons per annum, but actual production in 1953, following the severe drop in prices from high 1951 levels which had stimulated production, was only about 34,000 tons. This was slightly

less than internal requirements plus some exports to neighbouring South American countries. The capital invested in the industry is about 670 million Pesos (£2¾ million at ruling exchange rates) and the employment roll is currently about 4,000. At present, the Chilean Government is trying to revive activity in the industry by granting it facilities to participate in barter transactions and to dispose favourably of foreign currency earnings.

Deposits

The origin of the Chilean sulphur deposits which are situated generally on the slopes or in the craters of extinct volcanoes, is manifested in their occurrence in the form of sulphur flows, sublimations, and impregnation and replacement deposits. Of these, the last-named are met most frequently and they are the most important. They occur at or near the surface in more or less horizontal strata, often continuous for several thousand feet, varying in thickness from 2-20 feet, and occasionally even to 60 feet thick or more. The overburden is usually 10-30 feet high, and only in exceptional cases more than 100 feet. A cross-section through a deposit formed under ideal conditions would appear as follows:-

Fig. II



The principal layer of sulphur ore, or caliche, consists of yellowish-white ore containing 45-75% sulphur, but rich pockets of almost pure sulphur (85-95%) frequently occur, though its colour is darker, varying between brown and grey. The gangue material is almost exclusively pumicestone, silicious ashes, clay or, sometimes, gypsum. Chilean sulphur is practically free from deleterious impurities, such as selenium, tellurium and bitumen; it is generally free from arsenic but often contains fluourine. Due to the

impregnation by sulphurous gases, the silicious rocks overlying the sulphur strata are often bleached to an off-white colour, which phenomenon usually gives a superficial indication from afar of the presence of sulphur.

The occurrence of large and numerous sulphur deposits, few of which have been systematically surveyed and even fewer assessed in the light of economic ore extraction and sulphur recovery, makes an accurate assessment of the country's potential reserves virtually impossible. Various estimates have put reserves at 35-40 million tons sulphur, but these do not appear to have included lower grade sulphur ores, and are said to be limited to some 50 deposits in the provinces of Tarapaca, Antofagasta and Atacama.

Mining

Mining methods in the Chilean sulphur industry are almost without exception primitive. The labour force consists of Indians, better able to work under the special conditions resulting from high altitude and rigorous climate, which furthermore impose a limitation on working hours and cause seasonal interruptions. Generally sulphur ore is obtained by open-cast mining operations. Overburden removal and sulphur rock extraction are performed manually, explosive charges being used if necessary to loosen the rock. Occasionally, to expose additional working faces, crude shafts are driven into the rock strata, but they are rarely safeguarded by pit props, and it is more common to leave rock stalls hardened by ice to support the workings. Infrequently underground mining operations by adits are met and these are often subject to hot gas intrusions as the result of continued solfataric activity.

Ore removal to the refineries usually situated at lower altitudes is, in the majority of cases, by pack animal; some of the larger mining undertakings use an aerial ropeway or lorries. A number of mining enterprises now at various stages of development are introducing up-to-date mining and loading machinery, with a view to replacing manual labour.

Refining

Sulphur refining in Chile is almost exclusively carried out by melting the sulphur ore in stationary or rotary autoclaves using superheated steam. During the past fifteen years, sulphur sublimation in direct-fired retorts, which process was the more common, has been, with few exceptions, replaced by the use of autoclaves. Gill furnaces, such as used in Sicily, have been employed in the past, and attempts were made to extract sulphur from rock by dissolving it in hot saline solutions. Neither of these methods finds application today, being even more inefficient and uneconomic than the methods mentioned above.

The use of steam autoclaves, of many variants, generally permits the recovery of 50-60% of the sulphur content of the ore, and results in the loss of the sulphur contained in the fines tailings for which there is, with the exception of some small quantities supplied to the Chuquicamata copper refinery, no local use. Prior to the 1939-45 war the Chilean Government installed a 200-ton per day flotation plant at Amincha Nr. Ollague for the treatment of such sulphur tailings. Operations were not, however, successful and after the plant was completely gutted by fire, the project was abandoned.

There are three principal producers who have installed a modern refining plant or are planning to do so:

(1) Cia Aucanquilcha have installed a flotation plant of the Chemical Construction Company type, with a view to recovering the sulphur content of the fines tailings. Its operation only supplements the autoclaves which represent the company's main refining capacity. At present, due to limited sales, the flotation plant is not working.

(2) Soc. Azufrera Polan at San Pedro de Atacama employ a CS_2 solvent plant (Nagelvoort Process) which is designed to recover about 90% of the sulphur content of the ore. No details are as yet known of its performance and operation work.

(3) Cia Azufrera Purico envisage the installation of a Rheinhausen Stahlbau centrifuguing plant providing for the recovery of 80-90% of the sulphur content of

the general run of ore containing 50-60% sulphur.

Beyond these there appears to be no general desire on the part of the industry to instal new plant or adopt modern methods, nor is Government support to this end likely to be forthcoming.

Production

The following graph indicates sulphur production during the period 1945-1953:

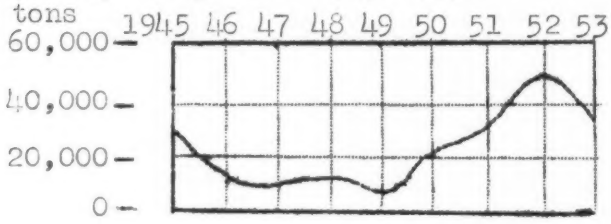


Fig. III

The principal producers are as follows:

Name	Location	Production (000s m. tons) 1952	1953	Capacity
Az. Aucanquilcha	Ollague	18.8	13.9	24.0
Az. Nacional	Arica	9.4	4.2	12.4
Az. Polan	San Pedro	6.3	5.8	12.0
Az. Purico	San Pedro	4.9	3.0	12.0
Az. Borlando	Ollague	4.5	4.1	7.2
Hector Rojas	El Tatio	1.8	2.4	6.0
Otmar Petrinovic	Ujina	1.5	.4	4.8
Az. Rozas	San Pedro	.7	-	4.8
Minera Polapi	Polapi	.3	-	4.8
Az. Libertad	Taltal	-	-	4.0
Rojas y Astorga	Antofagasta	1.5	-	3.6
Az. Codocedo	Copiapo	.2	-	3.6
Tomas Astorga	San Pedro	-	-	3.6
Juan Yutronic	Monturaqui	-	-	3.6
Minera Carmen	Ascotan	-	-	2.4
Az. Inca	Antofagasta	-	-	2.4
Roberto Vasquez	Antofagasta	-	-	2.4
Lahaye y Berger	Antofagasta	-	-	1.8
Az. Cabana	San Pedro	.4	-	1.8
Az. Andes	Antofagasta	-	-	1.5
Canepa y Cia.	Tarapaca	.4	-	1.2
		50.7	33.8	119.9

It is significant that more than two-thirds of the major producers are not working at all, or only intermittently.

The full employment, not to speak of the expansion of producing capacity, depends on the viability of Chilean sulphur in export markets, and these conditions do not at present obtain, although the plans of producers installing new plant are aimed at redressing this.

The high production costs, in particular of the medium and small undertakings, result from a combination of primitive mining methods and adverse climatic conditions, wasteful and uneconomic refining operations and high transportation costs of ore to the refinery and from refinery to users works or shipping ports. Added to this is the high cost of fuel, be it fuel oil, coal or indigenous timber (mainly yareta), which, incidentally, is becoming scarcer, and the difficulties of water supplies required by refineries. Frequently, water has to be piped for many miles, or, as much of the available supplies are strongly mineralised, made fit for use by costly purification.

The incidence on producers of the various impediments differ considerably and much has been done, especially by the large producers, to reduce their effect. The inherent weaknesses of current operations, however, remain, and it is thought that large scale economic production, which would secure Chile a permanent place in world sulphur markets can only be achieved by complete and appropriate modernisation and integration of the entire cycle in the light of local conditions, thereby ensuring the full and rational employment of available resources. The communications problem is, of course, to a large extent, outside the control of individual producers, and in this field, as well as in respect of the high level of the country's general cost structure, the matter rests in the hands of the Government.

Consumption

Sulphur consumption in Chile amounts to about 17,000 tons per annum, having been at this level during the past four or five years. Details of consumption are as follows:-

Rayon	4.0	(000s tons)
Nitrate for blasting powder	3.0	
Sulphuric acid	2.3	
Steel	1.0	
Chemical	.8	
Explosives	.4	
Agriculture+	4.5	
Nitrate and copper‡	1.5	
	17.5	

+ Ground and sublimated.
‡ In the form of 60-70% ore.

It is expected that during the next two or three years consumption may increase as the result of the proposed installation of a cellulose plant, which project has government support, and in respect of which the Export-Import Bank have agreed a loan of $12\frac{1}{2}$ million. A further increase of consumption may result from the installation of another acid plant by Cia Minera y Commercial Sali Hochschild, who are reported to envisage importing this from Germany.

Trade and Prices

The stagnation during 1953 of the Chilean sulphur industry was the direct result of the producers' inability to compete in world markets. At the time of the sulphur crisis Chilean producers were able to effect sales at prices as high as £70 per ton, but with the return of easier market conditions, their failure to keep in step with world prices eliminated them as marginal exporters.

The only export markets open to Chile were countries with high internal price structures, such as their South American neighbours, notably Argentina, and those with whom barter arrangements disguised the real sales price. These exports, as well as sales in the home market, have been effected at prices equivalent to £35-£40 per ton. Throughout 1953 their world quotations dropped, and simultaneously the number of producers able to quote, down to about £20 per ton f.o.b., below which there has been no further reduction.

A stockpile of nearly 30,000 tons accumulated at various refineries which was eventually taken over by

I.N.A.C.O. (National Institute of Commerce). To facilitate its disposal and to revive activity in the sulphur industry, the Government agreed in principle to a system of internal compensation which, early in 1954, resulted in 60,000 tons sulphur being sold in equal parts to the United Kingdom, France and Germany. The sulphur sales prices is reported to be about £11.16s. per metric ton f.o.b., the Chilean producers receiving compensation from the over-price obtained from sale of imported motor vehicles.

During recent weeks it has been reported that sulphur exports at world prices are envisaged independent of barter or compensation transaction. It is assumed that producers would be granted certain facilities by their Government to obtain a favourable rate of exchange for their currency earnings, either officially or by being permitted to sell their currency to importers. It is reported that sulphur exports are to be boosted to a level of 50,000-70,000 tons per annum. Exports of sulphur during 1952 were as follows:-

	M. tons	
Argentine	17.800	Incl. 800 tons) Bolivian origin
Brasil	3.500	Incl. 1200 tons)
Finland	5.400	
France	1.500	
Belgium	600	
	28.800	

No data are as yet available for 1953, but it is believed that only about 20,000 tons were exported wholly to Argentina.

Conclusion

Chile's importance to the sulphur industry of the world does not lie in its achievements as a producer but in the potential of its deposits. The present difficulties of the Chilean industry are common to all rock sulphur producers, aggravated by the comparative inaccessibility of the deposits and the transport conditions in this rather undeveloped country.

The present facilities (barter, internal compensation, currency sales), sponsored by semi-governmental

bodies such as I.N.A.C.O. and receiving government support, must be welcomed, as they represent an attempt to overcome the industry's limitation of high cost production by providing a temporary device to bridge the gap between actual production costs and world prices.

There is little doubt, however, that this can only be an interim measure which does not accord with the economic interests of the country as a whole. The developments undertaken by the few enterprising companies which promise rational production, point the way towards a solution and to the increased utilisation of the country's vast sulphur resources. To achieve this on a large scale it is thought that the stimulus of active foreign interest may be necessary.

PRICES AND TRENDS

Prices

Since the establishment of higher home and export prices in the U.S.A. on 1st January, 1954, the world price structure has undergone virtually no change. From Italy tentative offers of up to 30,000 tons sulphur at prices between £17-£20 per ton f.o.b. are reported, but there are no indications that actual sales have been effected at this prive level. Actual exports which, if anything, are at an even lower level than during 1953, are reported to be valued at Lire 42,000-45,000 (£24-£26).

Japanese sulphur exports appear to have come to a complete standstill since accumulated stocks were disposed of at below cost prices. At present, high production costs make Japanese sulphur about twice as expensive as U.S. sulphur.

In Chile, the successful conclusion in January of internal compensation transactions between I.N.A.C.O. and buyers from the U.K., France and Germany, each purchasing 20,000 tons, is reported to have made available sulphur at U.S. $32.10 to $32.90 per metric ton (Av. £11.16s. per ton) f.o.b. Chilean ports. It is understood that the Chilean Government favour similar facilities permitting further sales at such prices to stimulate future production.

	f.o.b. Country of origin	Freight to U.K.	c.i.f. U.K.
United States	$31 ($33)	46/- $16.50*	£13⅜ & £17 Av. say £14
Mexican Gulf	$31-$33	52/-	£14
Italy	£20	32/6	£21¾
Chile	£11¾	75/- (liner) 66/- (tramp)	£14¾ - £15¼
Japan	$38+	104/- (liner) 70/- (tramp)	£17 - £18¾
Iraq	-	-	£14

* 50% of U.S. sulphur exports have to be moved in U.S. bottoms; whereas U.S. liner freights are at present equivalent to about 50/-, U.S. tramps usually command premium freights.

+ Calculated on the basis of their sales to Australia.

Supply

The supply position in terms of cheap American brimstone is at present comparatively easy. The additional supplies during the first quarter from Garden Island Bay and Nash Domes of Freeport Sulphur Co., and Damon Mound of Standard Sulphur Co., have reversed the steadily worsening position of native sulphur production in the U.S.A. Although offtake by the U.S. home market has not risen from last year's levels, demand continues strong as a result of buoyancy in the chemical industry, which so far has not shown any notable signs of recession.

U.S. home demand is being met comfortably, and moderate additional demands of some non-American sulphur consumers appear to have been acceded to. At the same time, the view has been expressed in the industry that the forward supply situation remains tight. This is emphasised by the fact that although desired by the Administration and producers alike, no significant improvement to the level of stocks is being achieved. In this connexion it is not thought that the recent official announcement concerning stockpile policy will be applicable to sulphur.

The expectations of Mexican Frasch sulphur supplies reaching world markets this spring are not being realised, although, given success at overcoming the setback at San Cristobal (see Page 54), this may be possible during the summer months.

The above-mentioned transaction of 60,000 tons Chilean sulphur has brought about increased mining and refining activity in that country, as, in addition to last year's level of supply to the home and neighbouring markets, over 30,000 tons sulphur will have to be provided over the next nine months. Owing to stringent demands in respect of quality control by the buyers, no despatches against these contracts have yet taken place, but it is confidently expected in Chile that even though the stockpile material originated from a variety of producers, the quality requirements would be met. The Chilean Government appear to favour further expansion of production towards a fuller utilisation of installed capacity, and although the afore-mentioned facilities permitting producers to quote world prices cannot be more than temporary measures, any additions to world supplies must be considered welcome.

In Japan, production appears to have aligned itself with home demand, as there do not appear to be any export prospects at the price level necessitated by high production costs.

In Italy, not only are exports almost non-existent, but the home market has also contracted during recent months to a level of 80,000 tons per annum, and with production rising, due to guaranteed costs, the unsold stockpile continues to increase, and is estimated to be in the region of a ½ million tons. As mentioned on Page 32, renewed attempts to put the industry on a sound footing are being made by the Government and the producers, but there is little doubt that only the most drastic measures would permit Italy's entering competitively into world markets, and this is not thought likely to occur this year.

Neither Scandinavian nor German sulphur offers are reported, and the entire productions appear to be taken up by the home industries of these countries.

Based on incomplete data, it appears that during 1953 the world supply position was as follows:-

	Production (millions tons)	Consumption (millions tons)
Native and recovered sulphur	6.4	6.5
Sulphur in pyrites	4.5	4.4
Sulphur in other forms	1.6	1.5
Total	12.5	12.4

Compared with 1952, production appears to have ~~increased by less than 1½%~~ against a rise in consumption of about 9%. In the case of native and recovered sulphur, it might be added that about 130,000 tons of Italy's sulphur production failed to reach consumers, and requirements were met by reduction of stocks held by a number of consumers, notably U.K., and some producers.

The most significant feature of the 1953 position is the decrease of native sulphur production by nearly 150,000 tons, and the overall increase was only achieved by a rise in recovered sulphur production of over 200,000 tons. This increasing utilization of sulphur in waste, coal, natural and oil refinery gases, either in the form of recovered sulphur or as sulphuric acid, has been particularly pronounced in the U.S.A., and in Canada, in the early part of 1953, and more recently on a smaller scale in the U.K. and Europe. This trend continues and may be accelerated by the accumulated technical experience, and by any further rise in world prices of native sulphur that may make an increasing number of recovery schemes economically viable. Indications so far point to a further increase during 1954 of about 4-5% in production and 3-4% in consumption of sulphurous raw materials. Native and recovered sulphur and sulphur in other forms are expected to show a greater advance than sulphur in pyrites.

UNITED STATES SULPHUR

Native sulphur

During 1953 production of Frasch sulphur amounted to about 5,155,000 tons which is the lowest total since 1949, and which, compared with 1952, when 5,293,145 tons were produced, represents a decrease of about 138,000 tons, or 2.6%. Monthly output varied from a low of 370,468 tons in November, to a high of 479,954 tons in April. The rate of output was exceptionally high in the second quarter, decreasing to a low level in the last quarter, when production amounted to about 1,239,000 tons. It is estimated that individual producers' output was as follows:-

	1953 estimate (000s tons)	1952	Change
Texas Gulf Sulphur Co.	2750	2958	-7%
Freeport Sulphur Co.	1800	1692	6½%
Jefferson Lake Sulphur Co.	376	405	-7½%
Duval Sulphur and Potash Co.	220	238	-9%
Standard Sulphur Co.	10	-	New
Total	5155	5293	-2.6%

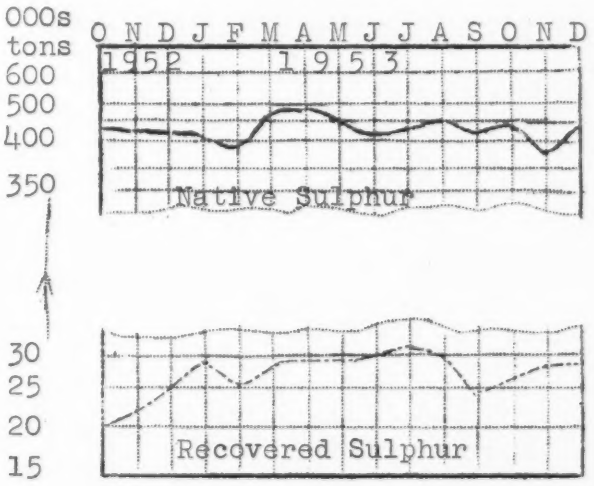
Production of native sulphur from surface deposits which, in recent years amounted to only 1,000-2,000 tons per annum in the form of low grade ores, increased to about 10,000 tons, as a result of operations starting in the autumn of 1953 at the Leviathan Mine in California, operated by the Anaconda Copper Mining Co. This mine is planned to produce 40,000 tons per annum refined sulphur and the entire output is captive, being consumed at the company's new copper mine at Yerington, Nevada, for sulphuric acid manufacture.

Apparent sales of native sulphur during 1953 amounted to 5,202,000 tons, the highest on record and representing an increase of over 140,000 tons (2¾% compared with 1952). Demand, which had receded in the third quarter, following the exceptionally high level of sales in the second quarter, which were stimulated by the impending price rise of June, 1953, recovered during the last quarter to about 1,275,000 tons. Compared with the same period of 1952 this represents a reduction of about 1%, although in December the level of sales again exceeded the 1953 average.

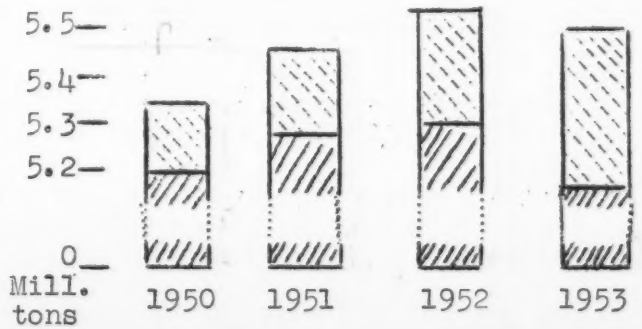
Exports during 1953 amounted to 1,241,536 tons, compared with 1,304,154 tons during the preceding year, a decrease of 5%. During 1953 stocks decreased by about 47,000 tons, and at the turn of the year amounted to about 3,022,000 tons. Except for a recovery during the third quarter, the decline of stocks was continuous during the year.

MONTHLY PRODUCTION FIGURES 1952 to 1953

Fig. IV



Annual Production Native & Recovered Sulphur



Recovered sulphur

Production of sulphur recovered from natural and oil refinery gases during 1953 amounted to 337,099 tons, compared with 248,576 tons in 1952, an increase of 36%. During the last quarter the level of recovered sulphur production regained a monthly rate of 28,000 tons, equal to the year's average, but this was still some 2,000 tons per month below the peak levels reached during the second quarter. Apparent sales during 1953 destined wholly to U.S. consumers amounted to 324,417 tons, compared with 222,626 tons in 1952, an increase of over 45%. Sales of 95,334 tons during the last quarter were the highest on record. At the end of the year stocks amounted to 107,334 tons, compared with 94,662 tons at the end of 1952.

Other sulphurous raw materials

It is estimated that production of sulphur in other forms during 1953 amounted to about 780,000 tons, compared with 755,000 tons in 1952, an increase of 4%. This total is made up as follows:-

	1953 estimate (000s tons)	1952	Change
Sulphur in pyrites	435 ~~435~~	418	4%
Sulphur in by-product acid from smelter gases	290	272	8%
Sulphur in by-product acid from hydrogen sulphide	55	60	-8%
Sulphur dioxide in liquid form from smelter gases	5	5	-
	785 ~~785~~	755	4%

The salient points in the developments in U.S. industry during 1953 are thought to be as follows:-

(a) Total production of native and recovered sulphur was about 50,000 tons, or 0.9% less than during 1952.

(b) Apparent consumption of native and recovered sulphur amounted to about 4,256,000 tons, compared with 3,947,000 tons in 1952, an increase of 8%, while exports receded 5% to under 1¼ million tons.

(c) Stocks showed a further though slight reduction due primarily to the substantial drop during 1953 of native sulphur output.

U.S. sulphur supplies during 1954 will be substantially increased by the addition of output from the new domes that came on stream late in 1953 and early this year. Their combined production capacities are in excess of 600,000 tons per annum, and additional capacity to be installed at Damon Mound by the autumn of this year should raise this by a further 60,000 tons per annum. Against this must be set the decline of output of some existing domes - notably Hoskins Mound, and possibly Boling Dome - which may amount to a quarter million tons.

Domestic sulphur consumption is expected to increase to meet the anticipated requirements of the new projects in the plastics, titanium, dyes and fertiliser industries. In connexion with the fertiliser industry which, in the form of acid, takes up about a third of U.S. sulphur consumption, the Department of Agriculture forecast in 1952 that by 1956 additional phosphatic fertiliser requirements would necessitate the use of nearly ¾ million tons sulphur. During 1953, in spite of a large increase of sulphur consumption for acid production in general, the use of acid for fertiliser manufacture dropped slightly. As anticipated in Bulletin No.3, the voluntary reduction of acreage has resulted in a tendency to bring about an increase of crop yield by the intensification of fertiliser use. This trend has been challenged by the Department of Agriculture as likely to cause a continuation of over-production of agricultural produce. The National Fertiliser Association, in turn, have taken issue on this subject.

A number of new fertiliser and sulphuric acid plants started production during the last six months, or are scheduled to do so this year, and these additional requirements are estimated to represent 200,000-300,000 tons sulphur. Given a continuation of the

present level of activity in the chemical industry, the margin between sulphur production and consumption should enable producers to build up stocks, although at best, 1954 may see only about nine months' domestic requirements above ground.

JEFFERSON LAKE SULPHUR COMPANY

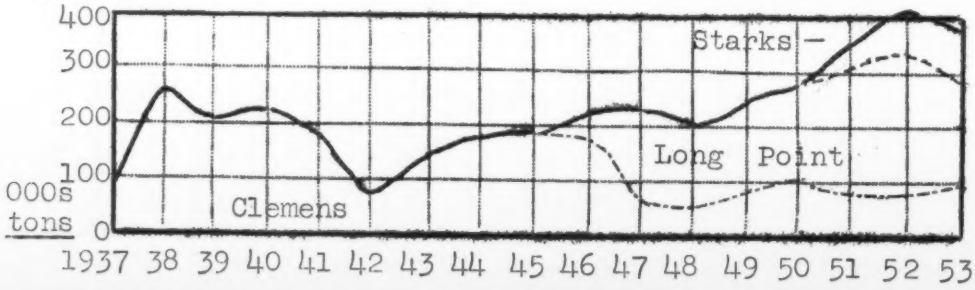
The third largest producer of crude sulphur in the world, Jefferson Lake Sulphur Company, celebrated its 25th anniversary in 1953. Originally engaged in oil prospecting, the company turned to sulphur production in 1930 on discovering the dome deposit beneath the lake bottom of Lake Peigneur in Iberia Parish, Louisiana, from which from 1932-36 nearly half a million tons sulphur were extracted. Following the exhaustion of this deposit the company started production at Clemens dome, Brazoria Country, Texas, in 1937, and has since added to its producing units Long Point Dome, Fort Bend Country, Texas, in 1946, and Starks Dome, Calcasieu Parish, Louisiana, in 1951.

Production

During 1953 production amounted to 375,883 tons, 7½% less than during the previous year. Details of the individual domes' output is as follows:-

	1952 (tons)	1953 (tons)	Change
Long Point Dome	249269	190018	-23½%
Clemens Dome	84329	98482	+17%
Starks Dome	71785	87383	+21½%

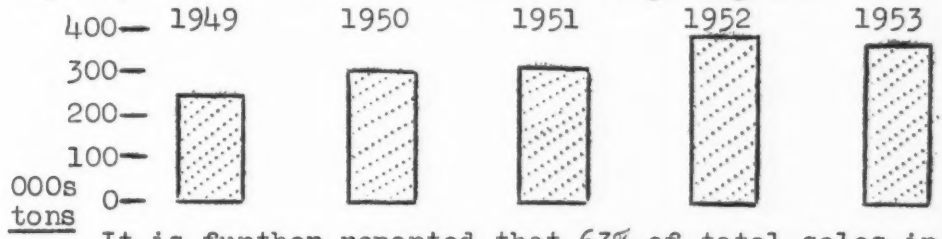
The following graph shows the development of production at the company's three domes for the period 1937-53.



According to the company's Annual Report for 1953 exploration work continues on the three operating domes, and further resources of sulphur in areas hitherto unexplored are indicated. The company is installing an extra boiler at Long Point which is to permit steaming and production from one or more additional sulphur wells.

Sales and Shipments

Sales over the last five years, as given in the report, are indicated in the following diagram.



It is further reported that 63% of total sales in 1953 were exported to fifteen foreign countries, whereas the company's domestic market consists, in the main, of 34 regular consumers. As previously reported in Bulletin Nos 2 and 3, the company's export price was raised twice since price controls were lifted in March, 1953, i.e. to $30.50 per ton f.o.b. Gulf port on 1st June, and to $33 on 1st January, 1954. The company expect that 1954 shipments should at least equal, if not exceed, those of 1953 in view of existing domestic and export contracts and the exceptionally good demand from foreign consumers. The company's stocks are reported to show an increase over the previous years' position.

Finance

The company reported a net profit before taxation of $1,998,762, which, after tax payment of $512,000, resulted in a net income for the year of $1,486,762, the highest on record. With effect from December, 1953, the company's dividend payments on common shares are being increased from 25¢ to 30¢.

Technical developments

A new system of heating mine water by a submerged combustion burner is now undergoing development on a pilot plant scale. The company expect to perfect this during 1954 and to use it in full scale operation at

one of the domes. The system provides for the heating of hard or soft sulphur mining water, and it is operated continuously on water, coming from bleed wells, which has a high hydrogen sulphide and salt content. By this process, hot water is recirculated, thereby effecting substantial economy.

Earlier development work in connexion with a sulphur cooling plant is to be exploited in conjunction with the Blaw-Knox Company with whom Jefferson Lake have concluded an agreement for its manufacture and sale. Described as a sulphur flaking machine, the unit already installed at Clemens dome has a rated capacity of 240 tons per day. It is designed to cause molten sulphur to solidify rapidly and facilitate its direct loading into transport or to storage by conveyor belt, thus obviating the earlier process of storing molten sulphur in vats from which the sulphur had to be drilled out or blasted after it had solidified. It is expected that the plant may find wider application by other sulphur producers and, possibly, in other fields.

Successful results are also reported regarding the company's other technical interests, such as gas dehydration and hydro-carbon recovery from natural gases and cresylic acid recovery from oil refinery wastes.

Sulphur recovery from natural gas

In December, 1953, Jefferson Lake Sulphur Company concluded an agreement with Socony-Vacuum Oil Company and seven other interested parties, shareholders in the Manderson sour gas field, Wyoming, to acquire the concentrated hydrogen sulphide gas, with a view to extracting its sulphur content. The recovery plant is to be built near Worland, Wyoming, and is expected to be completed in the autumn of 1954. It is to have a daily capacity of 130 tons sulphur, and, when development work in the gas field has advanced, its facilities are to be increased to 300 tons per day.

Summary

The company's exploration and development work, in particular, in the Leasehold area of Long Point dome acquired in 1952, promises continued satisfactory supplies. It appears, therefore, that the gradual falling off of production at the existing wells of Clemens dome may be more than made good by new exploitation and envisaged rising output at Long Point dome and particularly at Starks dome.

SURVEY OF SULPHURIC ACID IN THE UNITED STATES

Published by the Chemical and Rubber Division of the Business and Defence Services Administration, the Survey reviews sulphuric acid production and consumption during the years 1950-52.

Production

The restricted supplies of sulphur manifested in 1950 by producers' limited distribution controls and, later, by various control orders issued by the National Production Authority remaining in force up to November, 1952, substantially influenced acid production and expansion plans. At the same time, in order to mitigate the effects of rising demand, special emphasis was placed on expansion of facilities for producing sulphuric acid from non-elemental sulphur sources, such as pyrites, spent acid, smelter and refinery gases.

Total acid production in 1952 by commercial producers of 12.3 million tons[+] (100% H_2SO_4) was fractionally ($\frac{1}{4}$%) less than that during the previous peak year 1951 and about 2% higher than in 1950.

Total plant capacity (including government plants) at 31st December, 1952, amounted to 14,561,000 tons, an increase of 2$\frac{1}{2}$% during 1952, and of 10% since 1st January 1950. As virtually all the new capacity represented contact type facilities, and as chamber plant output declined, the proportion of contact acid production to total output had increased by 1952 to over 78%. The recovery of spent acid played an increasingly important role in particular connexion with supplies to the phosphatic fertiliser industry.

The following table shows details of spent acid recovery (000s tons 100% H_2SO_4).

[+] All quantities are expressed in short tons of 2,000lb.

	(000s tons) 1950	1951	1952
Total recovery	2006	2433	2513
Less used for decomposition to new acid	162	233	263
	1844	2200	2250
Of which for re-use as such	957	1216	1285
fortified at producing plants	887	984	965

Total acid supplies available to American industry were as follows:-

	1950	1951 (000s tons)	1952
Production			
Chamber	2956	2886	2709
Contact	9187	9503	9635
Total	12143	12389	12344
Recovery	1844	2200	2250
Imports	43	60	33
Grand Total	14030	14649	14627

The following graph based on the above Survey and on data published by the U.S. Bureau of Mines for earlier years, indicates the growth of acid production.

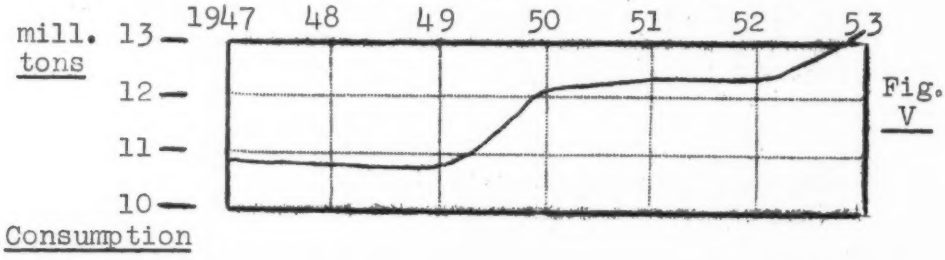


Fig. V

In 1952 sulphuric acid gross consumption of 14.6 million tons was approximately equal to that of the peak year 1951, but net consumption of 12.1 million tons was 1% lower, indicating the increased re-use of spent acid.

From 1950 to 1951 gross consumption had risen by 5% but net consumption by only 2%. This trend emphasises the efforts at conserving acid and thereby sulphur supplies.

	(000s tons 100% H_2SO_4) Gross	Net	Reused
1950	13897	11981	13.7%
1951	14653	12220	16.5%
1952	14644	12075	17.5%

Details of individual consuming industries are shown in the statistical appendix.

The largest single use of sulphuric acid in 1952 was for the production of phosphatic fertilisers, accounting for over one-third of the total net consumption. This is followed by acid use for ammonium sulphate (10¼%), inorganic pigments (10%), iron and steel pickling (7%). The findings of the report indicate that most of the changes in acid use resulted directly from the effects on the U.S. economy of the Korean emergency. In particular, acid use for commodities such as aviation petrol, alcohol, high tenacity rayon and petroleum catalyst, was so stimulated. The largest increase from 1950-52 in consumer groups was in chemicals, amounting to average 13%. Use for phosphatic fertilisers rose 7%, but ammonium sulphate decreased by 18%. Other notable changes are recorded in the use of acid in the production of inorganic pigments (-5¾%) and iron and steel pickling (-18½%), the latter largely attributable to the steel strike of 1952, but also to a change in 1951 in the type of steel items produced, as well as what was termed "a more frugal utilisation of acid".

Of the industries using large quantities of acid, but permitting a substantial re-use, the following might be mentioned ('000s tons 100% H_2SO_4):-

1952	Gross	Net	Re-usable
Alcohols	650	62	90.5%
Aviation petrol	1181	143	87.9%
Industrial explosives	375	64	82.9%
Insecticides	130	82	47.0%
Petroleum products	632	413	44.6%
Synthetic detergents	225	162	28.0%
Dyes	150	108	28.0%

The following graph indicates the growth of acid sulphur consumption based on the above Survey, and on data published by the Bureau of Mines for earlier years.

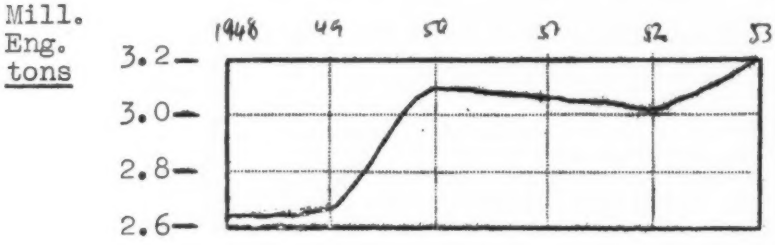


Fig. VI

It may be of interest to add that acid production and consumption increased substantially during 1953. Based on incomplete data an increase of about 7% is indicated, making total acid supplies available to American industry in 1953 about 15½ million tons.

The quantity of recovered acid available to industry is thought to be little in excess of the 1952 tonnage. The industries providing the largest quantities of spent acid are also those that increased their gross acid consumption, primarily as the result of the Korean emergency. Owing to the decreasing demands in this respect on U.S. industry during 1953, it is believed that the rate of increase of their gross acid consumption was slowed down, if not arrested, with corresponding effect on the amount of recoverable acid.

On the basis of preliminary data production of acid from pyrites increased by about 4%, and that from non-ferrous smelter gases by about 8%. It would appear that brimstone acid production in 1953 increased by about 7%, which is equivalent to an additional consumption of over 200,000 long tons sulphur over 1952, when the acid industry consumed about 3.0 million long tons sulphur.

SULPHUR IN ITALY

According to recent reports, the government control commission of the Ente Zolfi Italiani, which was established last autumn, has been withdrawn and the Government Commissioner, Signor Mastrobuono, relieved of his functions. The Ente Zolfi thus reverts to its former

normal administration, although it is believed that the division of functions into separate technical and commercial departments is being retained.

After the new Scelba Government was formed discussions were resumed at the Ministry of Industry and Commerce with members of the Sicilian Regional Government over the crisis in the sulphur industry, and to consider the methods proposed by the latter to alleviate the situation, which were outlined in Bulletin No. 3. These proposals have evidently proved to be too difficult to deal with promptly as would appear from the following press agency report:-

"The Ministry of Industry, in view of the complexity of the question which contains economic and social factors of considerable importance, considers that it should be examined from every angle and then referred to the Interministerial Committee for Reconstruction, prior to the preparation of a measure to be submitted to the Council of Ministers."

The embarassing position of increasing high-cost production and low level of exports continues in the meantime.

Production of raw melted sulphur during 1953 amounted to 227,750 metric tons, the highest on record since the war. This output represents an increase of about 12,000 tons, or $5\frac{1}{2}$ over 1952. Sulphur exports during 1953 amounted to 6,953 metric tons compared with 51,619 metric tons in 1952. It is reported that Italy recently concluded a Trade Agreement with Hungary which provides for the export during 1954 of sulphur valued at 60 million Lire, which is thought to represent about 1,500 tons sulphur.

OIL AS A SOURCE OF SULPHUR

The oil industry is today firmly established as an important producer of sulphur. In 1953 it accounted for about $\frac{1}{2}$ million tons sulphur - or 8% of world output - without making allowance for the substantial saving of sulphur occasioned by the regeneration of sulphuric acid sludges which is practised at many oil refineries. Of the above tonnage nearly two-thirds

result from recovery from natural sour gas (U.S.A., Canada and Mexico), and to a much lesser extent from coal-hydrogenation and from shale oil production, whereas about one-third accrues by recovery from oil refining gases. In this article it is intended to review the last-named aspect of sulphur recovery, since it is felt in many quarters, albeit outside oil circles, that a greater contribution to world supplies might come from this source. It is estimated that between one-quarter and one-third of the total world production of crude oil has a sulphur content in excess of 1.5%, notably Middle East crude oil containing 1.5%-2.5% sulphur, and about one-eighth of American crude oil output containing up to 5% sulphur. Thus, perhaps four million tons sulphur contained in crude oil enter oil refineries every year, of which at present less than 4% is recovered.

Broadly speaking, recovery of sulphur present in crude oil is governed by the intimate association of sulphur and hydro-carbons, with the result that it can only be isolated in recoverable form when the hydro-carbon structure is altered by processes such as catalytic cracking, polymerisation and hydrogenation. Fractional distillation, the basic process of modern oil refining to which all crude oil entering a refinery is subjected, only separates the various oil fractions in accordance with the natural proportions of any particular type of crude oil. The lighter fractions (e.g. gasolene, kerosene) representing about 25% by weight in the case of distilled Middle East crudes, contain only about 0.03% sulphur, of which only a negligible part is liberated with other gases and this, as a rule, is neutralised.

The sulphur content increases progressively through the range of gas oils to the heaviest residue but, of these oil fractions, only a comparatively small tonnage is subjected to one or other of the processes mentioned above, which, in addition to this primary function, also releases sulphur in the form of hydrogen sulphide accruing in a complex gas mixture. This may be used for firing purposes or be flared off but, if the sulphur is to be utilised, the hydrogen sulphide is extracted from the gas mixture, purified and concentrated by chemical treatment, usually by the Girbotol

(amine) process. Recovery of sulphur, unless the hydrogen sulphide is to be used direct for acid-making, thereby replacing an equivalent tonnage of sulphur, is usually affected by the now traditional Claus method.

In the U.K., for example, annual consumption of crude oil is at present about 30 million tons, of which 95% originates from the Middle East, and is estimated to contain about 650,000 tons sulphur. About one-quarter of the crude oil tonnage, containing, incidentally, about one-third of the total sulphur present, is potentially available as feed stock for catalytic cracking which process would permit the recovery of about 75,000 tons sulphur. As the installed catalytic cracking capacity is only 5.3 million tons, the total tonnage of sulphur deemed to be recoverable by this means is about 45,000 tons. Hydrodesulphurisation plants treating straight run or catalytically cracked gas oil may augment this figure perhaps by 30%-40%, depending on the extent of desulphurisation required and the extent of the market for desulphurised tractor oil.

Today, the statistical picture of sulphur recovery in the U.K. is as follows:-

	Annual capacity
Esso Petroleum Co., Fawley	12-14,000 tons
Shell Petroleum Co., Stanlow	12-14,000 tons
Anglo-Iranian Oil Co., Grangemouth	6,000 tons
Shell Petroleum Co., Stanlow (Hydrodesulphurisation plant to start in 1954)	?4,000 tons

In the U.S.A. production of sulphur recovered from oil refinery gases amounts to about 100,000 tons per annum. Outside the U.K. and U.S.A. as far as is known, sulphur recovery plants in operation or planned are as follows:-

France: Cie. de Raffinage, Shell-Berre, Berre-L'Etang, 4,000-5,000 tons per annum.

Cie. Francaise de Raffinage, La Mede - Planned

Netherlands: N.V. Bataafsche Petroleum Mij Pernis, 10,000 tons per annum.

Egypt: Anglo-Egyptian Oilfields Ltd., Suez
10,000 tons per annum.

The unrecovered sulphur is contained in the residual fuel oil and bituminous pitch, and from the point of view of the oil refiner, these fractions do not at present warrant treatment that might permit the recovery of sulphur. It is, however, encouraging that Standard Oil of New Jersey have developed an economically sound process ("fluid coking") for the transformation of residual fuel oil and bitumen into gasolene and heating oils. It is doubtful whether this process will find application while the pressure of crude oil supplies embarrasses the big oil companies.

To the oil refiners sulphur is a harmful impurity which, whenever necessary, must be neutralised or eliminated. There is no doubt that sulphur recovery alone could not justify the very costly installations that would be required to release sulphur in the form of hydrogen sulphide from oil fractions that do not warrant such treatment from an oil point of view. At the same time, it is considered desirable that sulphur recovery should be carried out when in the course of a necessary oil refining process hydrogen sulphide, however impure, accrues. At today's prices sulphur recovery generally appears to be remunerative and mere neutralisation of hydrogen sulphide is not thought justified, unless of course its arising is too small for economic recovery.

In Europe today installed catalytic cracking capacity amounts to about 15 million tons per annum, which alone would permit, on the basis of Middle East crude oil being used, recovery of about 160,000 tons sulphur per annum. As this capacity is considered to be much in excess of requirements, and as perhaps only three-quarters of feed stock so treated would come from Middle East crude oil, only a fraction of such a sulphur tonnage could be recovered, but there is little doubt that the figure is well in excess of 50,000-60,000 tons as at present achieved or planned by the oil industry, and probably nearer 100,000 tons as estimated by O.E.E.C. in 1951. This estimate did not take into account recovery of sulphur from hydrogen sulphide released in the course of hydrodesulphurisation of gas

oil, and it is indeed of little value to do so owing to the many variables involved. The indication in the U.K. may serve as a very approximate guide.

The increasing number of oil refineries in India and the Far East transpose the same question to a different setting, where, due to a greater dependence on sulphur imports, its implementation would bring even greater benefits.

UNITED KINGDOM SULPHUR

Consumption of sulphur in all forms during 1953 amounted to about 755,000 tons, the highest on record. Compared with 1952, consumption increased by about 150,000 tons, or nearly 25% and it exceeded consumption in 1950, the previous peak year, by about 1%. These sulphur requirements were met as follows:-

	1953	1952	1950
From			
Indigenous sources (sulphur in spent oxide zinc smelter gases, anhydrite and recovered from oil refinery gases)	34%	36%	26%
Sulphur in imported pyrites	23½%	16½%	12½%
Imported brimstone	42½%	47½%	61½%

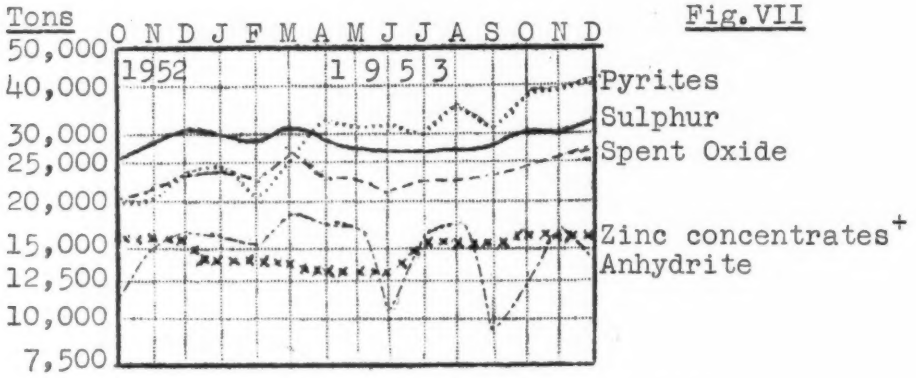
Consumption of the various raw materials was as follows:

	1953 tons	1952 tons	Change+	1950 tons	Change+
Sulphur acid regular	252900	226800	11½%	357600	-29¼%
	94700	79200	19½%	111600	-15%
Total	347600	306000	13¾%	469200	-26%
Pyrites	378100	217300	74%	205200	84½%
Spent Oxide	286000	231300	23½%	194400	47%
Zinc con.	174000	165100	5½%	176400	-1¼%
Anydrite	182800	178900	2%	184800	-1%

+Percentage figures shown indicate the change between the earlier periods and 1953.

The monthly consumption figures of raw materials are depicted below.

Fig.VII



+Note: graph based on quarterly data.

As apparent from the above graph the level of consumption of all sulphurous materials rose appreciably during the fourth quarter of 1953, during which period consumption in all forms was at the exceptional rate of 830,000 tons sulphur per annum. The outstanding feature was the further increase in the use of pyrites to an annual rate approaching ½ million tons, the highest level for nearly 40 years. Actual consumption figures for the third and fourth quarters of 1953 and fourth quarter of 1952 were as follows:-

	1953 4th Q.	1953 3rd Q.	Change+	1952 4th Q.	Change+
Sulphur					
acid	65900	57800	14%	63900	3%
regular	27500	22600	21½%	20000	37½%
Total	93400	80400	16¼%	83900	12¼%
Pyrites	116500	96200	21%	63100	84½%
Spent Oxide	76200	69100	10½%	65800	16%
Zinc con.	47300	45800	3½%	46200	2½%
Anhydrite	43800	43400	1%	43300	1¼%

+ Percentage figures shown indicate the change between the earlier periods and 1953.

Regular sulphur

It is estimated that consumption of sulphur for industrial use other than sulphuric acid manufacture was approximately as follows:-

	1953 tons	1950 tons
For Carbon di-sulphide	62000	56050
For Rubber compounding	9000	9700
For Sulphur dioxide, sulphites, etc.	9000	11200
For Agricultural purposes	5000	5250
For Dyes and ultramarine	3000	6250
For Wood pulp	2000	2150
For Export and miscellaneous	5000	20400
	95000	111500

Sulphuric acid

(a) Consumption

The total consumption during 1953 amounted to 1,901,800 tons[+], the highest on record. Compared with 1952 it was about 350,000 tons (22%) higher and 5% higher than during 1950, the previous peak year. During the fourth quarter 1953, it had risen to an annual rate of 2,050,000 tons, with December consumption at a rate of 2,120,000 tons per annum. The largest consumer was the fertiliser industry and production of super-phosphates and sulphate of ammonia accounted for over 40% of the total consumption. Next in order of size is the rayon and transparent paper industry which consumed about 12% of the total, followed by titanium oxide 9%, and iron and steel pickling 5%.

(b) Production

The production of sulphuric acid in 1953 amounted to 1,875,200 tons (100% H_2SO_4). Compared with 1952 this output represents an increase of about 370,000 tons, or 24½%, and it is 4% higher than production during the previous peak year 1950. During the last quarter of 1953, the pressure of demand caused acid production to rise well above the yearly average, attaining in December an annual level of over 2.1 million tons. Acid production resulted from the use of sulphur bearing raw materials

[+] Details of consumption of the various industries are shown in the statistical appendix.

in the following proportions:-

	1953	1952
Sulphur	38¼%	43%
Sulphur in pyrites	27%	20%
Sulphur in spent oxide	20¾%	22%
Sulphur in anhydrite	5¾%	6%
Sulphur in zinc smelter gases	8¼%	9%

Of the total acid output 1,216,700 tons (65%) were produced in contact plants, and 658,500 tons (35%) were produced in chamber plants. The total available acid capacity in the U.K. during 1953 amounted to 2,266,800 tons, an increase of 232,000 tons, or 9%, over 1952. Overall utilisation was 82.7%.

It is estimated that on 31st December, 1953, the total installed acid capacity (including brimstone acid 0.9 million tons per annum) amounted to 2.4 million tons per annum, and that by the end of 1955 additional acid capacity, amounting to 400,000 tons per annum, using pyrites and anhydrite as raw materials, is to be installed. The total capacity of plants using raw materials other than brimstone should then amount to 1.9 million tons per annum acid, with the balance of acid requirements to be met from brimstone burning plants. It had been envisaged that these brimstone requirements could be limited to about 130,000-140,000 tons per annum, or about one-third of the 1950 capacity.

The following graph depicts acid consumption, which, since 1948 has indicated a rising trend at the rate of 6% per annum, and production of acid from raw materials other than brimstone. Apart from small tonnages imported in 1951 and 1952, and the minor fluctuations between acid production and consumption, the shaded area represents acid production from brimstone. For the years 1954 and 1955 it has been assumed that plants using raw materials other than brimstone would operate at 90% of their capacity. It will be seen that to balance anticipated acid requirements the use of nearly 250,000 tons brimstone in 1954 and over 200,000 tons in 1955 is indicated.

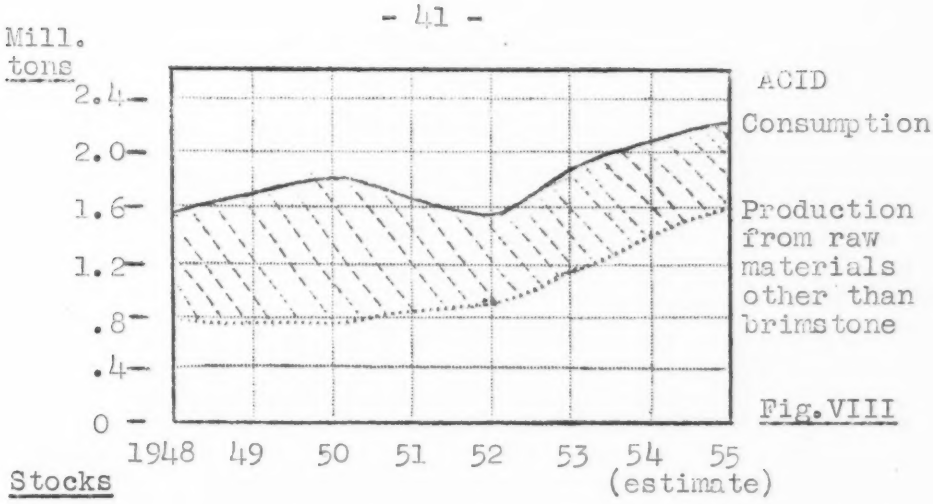


Fig.VIII

During the fourth quarter of 1953 sulphur stocks declined further by about 42,000 tons, and end-year inventories amounted to only 67,000 tons. Pyrites stocks are believed to have been maintained near the ½ million ton mark, whereas spent oxide stocks showed a further decrease to 278,000 tons. For the whole of 1953 stocks of sulphurous raw materials in general have declined appreciably, mainly as a result of the running down of sulphur stocks from the end-1952 level of 210,000 tons. At the current rate of consumption end-year sulphur stocks represent about two months' consumption.

The most significant features of sulphur developments during 1953 are thought to be as follows:-

(a) The high level of sulphuric acid production which, during the fourth quarter exceeded a rate of two million tons per annum, and which, in line with seasonal trends, has been maintained at this level during the early months of 1954.

(b) The substantial increase in pyrites consumption as the result of new acid plants planned under the conversion programme coming into production.

(c) The indication that "acid" sulphur requirements in 1954 would remain at a level similar to 1953, and higher than had been anticipated.

CURRENT EVENTS

United Kingdom

Exit Gas Purification Plant

Towards the end of 1953 a new Exit Gas Purification Plant was put into operation at the Avonmouth Works of The National Smelting Co. Ltd. This plant reduces by more than half the SO_2 content of the exit gases which previously passed to the atmosphere from the Acid Plant. Part of the recovered sulphur dioxide is concentrated, dried and returned for reuse to produce sulphur acid, part after scrubbing with ammonia to yield ammonium bisulphite is turned into ammonium sulphate by the addition of sulphuric acid. Apart from the appreciable sulphur recovery, the gas cleaning process is also found to improve the output of the acid making plant. General information on this plant is due to be published in the Company's House Journal.

Australia

Potential source of by-product sulphur

It was reported in the latter half of February that the Australian subsidiary of the Power Gas Corporation of Stockton-on-Tees are to construct a £1 million plant for the manufacture of high grade town gas from heavy petroleum oil, along with the recovery of valuable by-products.

This plant is to be erected for the Petroleum and Chemical Corporation (Australia) of Sydney. Although initially no sulphur recovery equipment is included in the plant, it is understood that this may be included at a future date, resulting in the recovery of about 1.500 tons sulphur per annum.

Addenda

The following information, which has come to hand since the survey of the Australian sulphur industry in Bulletin No.3, amends certain details referred to therein:-

(a) Sulphuric Acid Ltd., the company whose projected plant at Birkenhead is to utilise Nairne pyrites, was formed by the following three fertiliser companies only:-

Wallaroo Mount Lyell Fertiliser Ltd.
Adelaide Chemical & Fertiliser Co. Ltd.
Cresco Co. Ltd.

Together, they subscribed £A300,000 of the authorised capital of £A600,000.

(b) The ammonium sulphate plant, which it had been reported the Queensland Government were constructing at Brisbane, appears to be still at an early project stage, and it is now understood that no steps have yet been taken to start actual construction.

(c) Prices

The price of sulphur to Australian consumers was reduced from £A25 to £A20.10s., the reduced price to be applicable as from 1st July, 1953.

As regards pyrites prices, it is understood that pyrites concentrates from Mount Morgan may be available at about £A4 per ton f.o.b. Gladstone.

The Australian Tariff Board indication of the substantial disparity between acid prices in the U.S.A. or the U.K. compared with the Australian prices is understood to result from the comparison being made with exceptionally high cost acid. Most of the acid produced from imported brimstone is said to cost approximately half the amount indicated by the Australian Tariff Board (£A21.10s.3d.) and thus compare favourably with U.S.A. and U.K. acid.

Canada

New sulphur recovery plant

The Shell Oil Co. of Canada are about to start constructing a new plant to recover the sulphur content of the natural gas output from the company's Jumping Pound field at West Calgary.

The new plant, which is to cost $2½ million, will more than double the production from the company's existing sulphur plant at Jumping Pound which is currently producing at the rate of about 10,000 tons per annum. The new project is integrated with development plans of the Gunnar Gold Mines, who, at their Beaver Lodge mine workings, are building a $1 million sulphuric acid plant. Gunnar Gold Mines, who are planning production at the rate of over a thousand tons of ore per day, will require sulphuric acid for uranium recovery. Both Shell's sulphur recovery plant and the new sulphuric acid plant are scheduled to start operations by mid-1955.

It is understood that Shell's expanded sulphur programme is to be made possible by a substantial increase of natural gas deliveries to Canadian Western Natural Gas Co., which supplies Calgary and district. The sulphur is present in natural gas in the form of hydrogen sulphide, which it is necessary to remove before natural gas can be used commercially. The recovery process at the new plant will follow established lines.

United States of America

Freeport Sulphur Company

According to the company's Annual Report, sulphur production, sales and net earnings in 1953 were the highest on record in the company's history. Net income after all deductions, including depreciation, depletion and reserves for taxes, was $8,536,335, or $3.56 per share of outstanding common stock, compared with $3.05 per share in 1952.

It will be recalled (see Bulletin No.3) that Freeport Sulphur Co. started operations at the new Garden Island Bay dome in November, 1953. Less than three months later the dome had reached its planned production capacity of 500,000 tons sulphur per annum, and it is reported to be producing satisfactorily at this peak rate.

Early in February, 1954, the company announced that its new producing unit at Nash dome in Fort Bend County, Texas, 35 miles south-west of Houston, had started operations. This new dome is planned to produce about 70,000 tons per annum sulphur.

Of the company's four new projected domes only one, the Chacahoula dome in Louisiana Marshes, 60 miles west of New Orleans, is still in the development stage. This dome, due to come into operation either late this year or early next year, is intended to replace the output from the failing Hoskins Mound. and it is expected to yield about $\frac{1}{4}$ million tons per annum sulphur. Already, the total production capacity of the various Freeport domes exceeds 2 million tons per annum, and there is little doubt that a similar tonnage will actually be produced during the current year.

Standard Sulphur Company

Sulphur production which started last autumn at Damon Mound, 20 miles south of Rosenberg, Texas, continues satisfactorily at the rate of 200 tons per day. The company use a small scale standard type Frasch process extraction plant which, instead of resting on permanent foundations, is shackled to steel sledges, so that the plant and its component parts can be moved quickly to other parts of the dome when sulphur in the immediate area of operations is exhausted. This arrangement also eliminates the need for long water or air lines from plant to well.

The company holds a total leasehold area of 800 acres at Damon Mound, which was the scene of unsuccessful operations by the Union Sulphur Co. in 1925/6, and subsequent exploration by Jefferson Lake Sulphur Co.

The water capacity[+] of the plant, at present ½ million gallons per day, is about to be doubled, with the result that, as from the last quarter of 1954, production is expected to amount to 120,000 tons per annum.

The sulphur produced by the company is bright yellow and is free from deleterious impurities. It is estimated that the present deposit may yield about ½ million tons sulphur, so that the plant may remain static for a few years at least. The company, in addition to domestic commitments, export a proportion of their output, at present at a price of $33 per ton f.o.b. Port Galvaston.

New sulphur recovery plant

The Sinclair Refining Company of New York announced recently that they were installing a sulphur recovery unit at their oil refinery at Houston, Texas. The new plant will produce 30 tons of sulphur per day, which is to be recovered from the refinery gas streams. The plant is being designed and will be installed by Ralph M. Parsons of Los Angeles on the established lines of some sixteen plants installed by this contractor over the past few years. The Sinclair Refining Co. already operate a sulphur recovery plant at their Marcus Hook, Pa., refinery with a daily capacity of 20 tons sulphur.

Off-shore sulphur

In early February, 1954, the U.S. Department of the Interior issued provisional regulations in respect of leases for the development of sulphur, oil, natural gas, and other mineral resources, of the Continental Shelf. Leases, each covering an area not exceeding 5,760 acres, are to be issued on the basis of competitive bidding.

Sulphur leases would be valid for ten years -

[+] It has been found that, subject to local conditions, the production of 1 ton of sulphur requires 1500-4000 gallons of water, and the use of 2800 gallons/ton sulphur is deemed a fair average.

oil and gas leases for only five years - and for as long thereafter as production or plant construction were carried on. Royalties in the case of sulphur leases are proposed at not less than 5%, those on oil and gas at not less than 12½%. Other regulations cover unit plans, drilling agreements, etc., and additional regulations are to be issued to cover detailed exploitation rules.

The recent successful development of Garden Island Bay dome of the Freeport Sulphur Co. in the tidal marshes at the mouth of the Mississipi River add substance to the contention that the Texas and Louisiana dome formation extends along the Continental Shelf into the Gulf of Mexico. It is believed that tentative exploration and exploitation plans are in hand by one or more of the principal American sulphur producers. Although the difficulties of such exploitation are considerable, the experience gained by Freeport Sulphur Co.'s technicians in existing projects would, undoubtedly, be of value.

Sulphur deficiency in soils

It is reported that the American Department of Agriculture has expressed the fear that the increasing use of concentrated fertilisers with reduced sulphur content, may lead to a sulphur deficiency in the cotton growing soils of the South.

Cotton uses about as much sulphur as phosphorus and the sulphur leaches from the soil more rapidly. Many soils in the southern states are known to be deficient in sulphur, yet it is seldom, if ever, specially applied because, in the past, fertilisers carried sufficient sulphur to meet requirements. In the last ten years, however, the concentration of the primary ingredients - nitrogen, phosphorus and potash - in mixed fertilisers has increased. An increase of nearly 6% (18.3% to 24.2%) between 1944 and 1952 is expected to rise by a further 10% (to 34.9%) by 1955, whilst the sulphur content in such fertilisers has decreased.

Germany

Gas desulphurisation

The coking plant Nordstern, of the Rheinelbe Bergbau Aktiengesellschaft, Gelsenkirchen, the reconstruction of which, after war damage, was completed last autumn, and which is claimed to be the largest coking plant in Europe, incorporates extensive facilities for the desulphurisation of its gas output.

In conjunction with the ammonia recovery plant, one half of the gas output (about 900,000 cubic metres per day) is desulphurised by means of ammonia by the Pauling process. The other half is cleaned by a selective wet process utilising the free ammonia content of the gas. The extent of desulphurisation obtained by these means is 55%.

The resultant hydrogen sulphide arising at the rate of 480 Kg. H_2S per hour is converted into sulphuric acid, and with the coking plant working at full capacity, daily acid output is 33 metric tons (100% H_2SO_4). The hydrogen sulphide gas stream is initially cooled to 30°C. Subsequent combustion at 1,100-1,200°C yields gases containing (by volume) 4-5% SO_2, 10% O_2, 3% CO_2, and heat exchange permits the production of 1.4 tons per hour steam. The conversion takes place in a Petersen tower, and results in 58-60° Be' acid. To meet nitrous oxide losses, it is foreseen that a 10% mixture of ammonia and air is to be oxidised by means of a platinum catalyst, which process will obviate the need for nitric acid replacements.

Italy

Phosphatic fertiliser plant

The construction of a new phosphatic fertiliser plant was started recently by Porto Empedocle. The plant is owned by a subsidiary of Montecatini, Soc. Akragas, and it is designed to provide the requirements of Sicilian agriculture and also to provide a new source of supply for Italian fertiliser exports

to Egypt and other Middle East countries.

The plant is designed to produce 30,000 tons per annum triple super-phosphate (45-47% P_2O_5), or 50,000 tons of high grade super-phosphate (22-24% P_2O_5). Acid requirements of the plant are met by an oleum unit with a daily capacity of 100 tons mono-hydrate. The phosphoric acid plant has a daily capacity of 30 tons P_2O_5.

It might be mentioned that, with the exception of the oleum unit and gas compression equipment, the entire plant is of Italian construction, and provision is made for its future expansion, in particular with a view to producing nitrogenous fertiliser. The sulphur requirement of the acid plant is met by supplies of Sicilian brimstone at the rate of about 11,000 tons per annum.

Sweden

Sulphuric acid from smelter gases

The Bolidens Gruv Aktiebolag have installed a new sulphuric acid plant at their smelter plant at Ronnskar. Utilising the sulphur dioxide resulting from the smelting operations of copper and lead ores, the new plant at present produces at the rate of 30,000 tons (100% H_2SO_4) per annum, and it is to be increased gradually to a maximum capacity of 50,000 tons. Before the war Bolidens recovered some of the sulphur dioxide arisings in a plant producing elemental sulphur, but when this plant was dismantled these gases were allowed to escape to the atmosphere.

Recovered sulphur

The only production of elemental sulphur in Sweden takes place at the refining plant of Svenska Skifferolje Aktiebolag at Kvarntorp, who are treating oil bearing shales from which they produce annually about 3¼ million gallons of petrol, 12 million gallons of fuel oil, and 21,000 tons of sulphur. During the financial year 1952/3, the company's operations resulted in a net profit of Kr.38,000 after provision for depreciation totalling Kr.5.4 million.

U.S.S.R.

Research into sulphur and sulphuric acid production from coal pyrites and anhydrite

The problems of utilising coal pyrites and anhydrite, in conjunction, for the production of sulphur and sulphuric acid are examined in an account+ of experimental work carried out in 1951. The application of a suitable process is stated to be of great importance to a number of districts and republics, notably the Ukraine, which, though lacking iron pyrites deposits, have an abundance of the above mentioned raw materials and could thereby meet their sulphur requirements for acid manufacture.

The experimental work was carried out with carbonaceous pyrites (containing about 36% sulphur and 3-15% coal) and anhydrite (21.3% sulphur), which, when mixed and briquetted, were found to be in the most suitable form for the envisaged process. The effects, temperature, moisture, combustion rate, admixture of alumina, etc., were determined on charges containing varying proportions of the above raw materials.

The author, Mr S.N. Ganz, concludes as follows:-

(1) The highest yield of elemental sulphur (83-84%) and the greatest hydrogen sulphide content in the gas is obtained with a moisture content of 8-12% in the air or air/oxygen.

(2) To achieve a high degree of decomposition of anhydrite (96-97%) the process must be carried out at temperatures of 1,100-1,150°C.

(3) To obtain greatest gas concentration, the air blast must be enriched by oxygen, although free oxygen should be absent from exit gases, or should not exceed 1-1½% owing to the adverse effect of oxygen on the decomposition of anhydrite.

+ Published in the Zhurnal Prikladnoi Khimii (Journal of Applied Chemistry) 1953, 26, No.5, pp.467-474.

In the course of experiments it was also found that the amount of sulphide sulphur separating out (96.4-99.1%) was almost unaffected by the presence of anhydrite in the charge, whereas the greater the proportion of pyrites and, in particular, of coal and/or alumina in the charge to anhydrite, the more complete was the decomposition of anhydrite and, consequently, the higher the total percentage of hydrogen sulphide and sulphur dioxide in the exit gases.

Most, if not all, the results of this investigation are thought to be known in the U.K. and Germany where extensive anhydrite utilisation has been carried out for over twenty years, even though the simultaneous use of coal pyrites has not been applicable. In the U.K. the output of coal pyrites is about 5-6,000 tons per annum, or about half the tonnage produced during the war. Their principal use is not, however, in conjunction with anhydrite, but as inferior substitutes for imported iron pyrites. The greater scope of modern coal cleaning operations could, if necessary, yield a very substantial tonnage of coal pyrites, but it is understood that under present circumstances this could not be achieved economically.

It is not known whether, since the conclusion of the above experiments, the process has found practical application in the acid industry of the U.S.S.R.

Turkey

New developments

A new sulphur deposit has been discovered near Osmaniye in the province of Antakya. No accurate details are as yet known of its extent, but it is reported that a large tonnage of high grade sulphur is indicated.

The extensions to the Keciborlu sulphur refinery consisting of a new flotation and refinery plant, are reported to be progressing satisfactorily, and it is expected that in August of this year, the new plant will come into operation, thus raising Turkey's sulphur producing capacity to 15,000 tons per annum.

Proved reserves are estimated to amount to several million tons of ore, and these have been augmented during the past three years as the result of development of important deposits of high-grade ore containing about 60% sulphur. At present, Keciborlu produces about 7,000 tons per annum which barely meets Turkey's requirements. Most of the additional output is likely to be needed for transformation into ground sulphur for use in agriculture, and for the growing needs of the fertiliser industry. It is expected that a limited tonnage may be available for export.

A further development in Turkey's sulphur industry is the envisaged construction of a contact sulphuric acid plant at the Murgul copper mine in Eastern Anatolia. The plant is to be built by a French company, and it will utilise the sulphur dioxide content in the gases of the reverberatory furnace and the copper converter. Its completion date is planned to be midsummer 1955. This development is being integrated with the envisaged construction of a phosphatic fertiliser plant at the Black Sea port of Hopa, some 15 miles distant from Murgul.

Iraq

Iraq - Texas Gulf Sulphur Company

Following the announcement in December, 1953, that an agreement between the Iraq Government and the Texas Gulf Sulphur Co., in respect of the exploration and exploitation of the sulphur resources in Iraq north of the 33rd Parallel, awaited merely the ratification of the Iraq Government, it came as a surprise when, early in February, it was announced that the Iraq Council of Ministers had rejected the proposed terms.

The Acting Minister of Economics, Mr Kammuna, indicated that four amendments to the proposed clauses were required to make the agreement acceptable, and these the Texas Gulf Sulphur Co. refused to consider, resulting in the rejection of the agreement.

It is understood that the points at difference concern the period and rental terms of the leasehold

areas, and the scope of rights to exploit raw materials containing sulphur. It is believed that the new conditions stipulated by the Iraq Government are at present being reconsidered by Texas Gulf Sulphur Co., and it is expected that negotiations may be resumed on a new basis in the near future.

Mexico

Texas Internation Sulphur Company

In addition to the company's activities in Lower California (see Bulletin No.3), where small-scale production of sulphur by autoclave refining of sulphur rock at the rate of 25 tons per day is due to start on April 1st, the company have intensified their activities in their concession area on the Isthmus of Tehuantepec, through their associated Mexican company Central Minera S.A.

In September, 1953, this company concluded a 20 year agreement - with option to renew for a further 20 years - with the Mexican Government agency, La Comision de Fomento Minera, who control the National Reserve of over 2¼ million acres on the Isthmus. By this agreement the company have exploration rights over 50,000 hectars (123,550 acres), of which 106,732 acres have been specifically located and 16,818 acres are in the form of a floating concession which may be selected by the company over a period of one year for exploration anywhere in the National Reserve.

The company is obliged to invest during the next five years 2.9 million Pesos (£120,000) in machinery and equipment required for geological and geophysical investigation and core drilling operations. Within eighteen months of the production period starting, the company is obliged to invest 20 million Pesos (£825,000) in plant construction and the Mexican Government is to receive the usual royalty of 10% of the sulphur produced.

At present the company is believed to be engaged in making adequate financial provisions to meet the requirements of a thorough exploration programme, in connexion with sulphur domes already located in their concession area.

Mexican Gulf Sulphur Company

Early in January operations at the new San Cristobal dome of the Mexican Gulf Sulphur Co. came to a halt when, in the course of operational steaming pressure being applied, plugs blew into nearby disused oil wells of the old Aguilar Company. It is reported that work is in progress to seal off the escapes, and that it is hoped to resume steaming operations before long. In view of its importance as the first dome in this new production field, results are awaited with interest.

It may be of interest to add that, pending the construction of a loading jetty adjacent to the company's plant, sulphur is to be transported in liquid state in specially constructed barges to Puerto Mexico, where temporary storage facilities have been established.

Cuba

New pyrites production

Of several known pyrites deposits in Cuba, one, in the district of Corral Nuevo in the province of Matanzas, is now being exploited by the Cia Minera Cortes S.A. of Havana. The pyrites are reported to be present as a massive deposit and exploitation is carried out by open cast mining.

The mineral consists mainly of iron sulphide with small proportions of copper sulphide, and it is reported to assay 48% sulphur and 1% copper. According to available records, pyrites exports up to June, 1953, amounted to 17,000 tons, of which 13,000 tons were exported to Italy, and 4,000 tons to Belgium. The ore is shipped from the port of Matanzas.

Trinidad

Sulphur recovery plant

It was reported in January, 1954, that the sulphur recovery unit at the oil refinery of Trinidad Leaseholds Ltd., at Trinidad, is now working satis-

factorily, and is producing sulphur at an annual rate of 4-5,000 tons.

Standard methods of recovery are employed, but it is of interest that the molten sulphur is solidified into small pellets about ¼" diameter by pouring it from some height into water. The resultant sulphur is extremely pure, containing average 99.7% sulphur and free from arsenic, selenium, tellurium, and shows small quantities of bitumen content only. The immersion into water, however, causes up to 5% water being absorbed initially, but it is believed that much of this evaporates during storage and, in the case of export-sulphur, during transport to works.

The oil refinery has a varying annual consumption of up to 1,500 tons sulphur, the balance being available for export, and this tonnage has recently been contracted for by U.K. chemical interests.

Brazil

Sulphur recovery from coal pyrites

It is reported that the Cia Enxofre Nacional Ltda., of Rio Maina, in the township of Criciuma, in the State of Santa Catarina, have successfuly completed experimental work at pilot plant stage of sulphur recovery from coal pyrites. The process involves the following stages:-

(a) Dressing of coal pyrites by selective grinding.

(b) Combustion of pyrites concentrate.

(c) Reduction of the gases containing sulphur dioxide by means of a carbonaceous and pyritic bed.

(d) Reaction between hydrogen sulphide and sulphur dioxide in the presence of catalysts, such as sodium carbonate and titanium dioxide.

(e) Recovery of sulphur by means of heat exchangers and a sulphur spray tower.

At the pilot plant stage 6-8 tons per day sulphur were being produced, and at present work is reported to be in hand to erect a plant producing 30 tons per

day. The plant is financed by twelve South Brazilian coal mining companies, the Fabrica Celulose e Papel, S.A., of Canila (Rio Grand do Sul) and Cia Electro-Quimica of Porto Alegre. The process was developed, and work is under the direction of Professor Galeno Pianta.

Japan

Refining of low grade sulphur ores

The Tamatsukuri Sulphur Company is building a plant to refine ores containing as little as 20% sulphur.

The process was developed by the Noguchi Laboratory of Nippon Chisso, a leading rayon producer. Operation is to be continuous and labour-saving, and the 300-ton per month plant now under construction will only require 15 operators. It is expected that this plant will more than halve present production costs, and produce sulphur at about £11 per ton.

It is also reported that the Miura Chemical Industries Ltd., have successfully completed research into the refining of low grade ore, but so far no practical application of their process is believed to be envisaged.

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STATISTICAL APPENDIX

NEW ZEALAND

Year ending 30th June	Sulphur Imports	Sulphur Consumption[ø]	Super-phosphate[+]
	(Thousands tons)		
1939	41.2	51.1	460e
Av. 1940-44	49.9	47.9	412
Av. 1945-49	58.8	56.2	488
1950	62.5	72.0	637
1951	73.6	72.0	633
1952	84.0e	67.0	559
1953	94.0	70.0	604

e = estimated. ø For acid production.
+ = content of fertiliser production.

U.S. EXPORTS 1953

	Long tons		Long tons
Canada	317,630	Greece	778
Cuba	14,700	Belgium	34,000
Mexico	40	Yugoslavia	197
N. Antilles	15,000	Israel	3,300
Brazil	69,159	Iraq	886
Argentina	14,881	Bahrein	833
Venezuela	655	India	50,949
Guatamala	40	Pakistan	248
Dominican Rep.	297	Philippines	14,900
Paraguay	65	Indonesia	3,100
Uruguay	2,500	Australia	139,875
Ecuador	36	New Zealand	100,537
U.K.	182,032	Algeria	21,816
France	93,333	Tunisia	15,500
W. Germany	12,500	Egypt	1,444
Austria	18,505	French Morocco	10,000
Switzerland	23,750	U. South Africa	76,000
Sweden	2,000	Others	50

Total 1,241,536 Long tons

SULPHURIC ACID CONSUMPTION

U.S.A. (000s short tons net 100% H_2SO_4)

	1950	1951	1952
Alcohols	53	62	62
Aluminium sulfate (water & sewage)	83	95	85
Aluminium sulfate (other uses)	280	298	275
Ammonium sulfate (coke oven)	639	678	608
Ammonium sulfate (synthetic)	869	483	628
Aviation gasoline	144	120	143
Chemicals unclassified	952	1,152	1,199
Chlorine drying	16	19	19
Chromium chemicals	64	86	60
Copper sulfate	20	31	27
Dyes	145	145	108
Fat splitting	18	16	15
Hydrochloric acid	129	137	128
Hydrofluoric acid	114	137	135
Industrial explosives	64	71	64
Industrial water treatment	30	35	30
Inorganic pigments	1,245	1,251	1,174
Insecticides	81	78	82
Iron & steel (pickling)	1,026	953	838
Light oil refining(coke oven)	51	57	52
Medicinals	28	37	33
Nonferrous metal pickling	22	18	18
Other nonferrous uses	172	198	178
Petroleum products	406	407	333
Petroleum catalysts	123	143	155
Petroleum sulfonates	69	86	85
Phosphatic fertilisers	3,790	3,944	4,053
Rayon (high tenacity yarn)	192	197	274
Rayon (other)	354	359	255
Cellulose film	124	131	105
Rubber (including synthetic)	103	131	106
Storage batteries	78	74	60
Synthetic detergents	149	157	162
Tall oil	37	46	39
Textile finishing	37	31	28
Miscellaneous	274	357	459
Total	11,981	12,220	12,075

U.K. (000s E. tons 100% H_2SO_4)

	1952	1953
Accumulators	9.3	10.0
Agricultural purposes	8.2	9.5
Bicromate & Chromic acid	13.3	9.5
Bromine	12.2	15.9
Clays	7.3	9.2
Copper pickling	2.4	3.7
Dealers	10.5	12.1
Drugs & fine chemicals	14.9	14.1
Dyestuffs & intermediates	44.5	68.2
Explosives	24.7	31.8
Export	1.6	2.6
Glue	0.4	0.5
Hydrochloric acid	52.6	54.3
Hydrofluoric acid	11.1	11.9
Iron pickling	98.6	96.5
Leather	3.1	4.2
Lithopone	9.4	11.9
Metal extraction	1.8	4.0
Oil refining & petroleum products	70.7	64.2
Oils (vegetable)	10.3	11.2
Paper, etc.	3.6	5.3
Phosphates (industrial)	0.9	1.4
Plastics	19.5	21.1
Rayon & transparent paper	152.4	232.6
Sewage	9.4	11.2
Soap & glycerine	19.3	30.7
Sugar refining	0.6	0.6
Sulphate of ammonia	278.5	287.3
Sulphates of copper, nickel, etc.	26.2	20.5
Sulphate of magnesium	3.7	5.1
Super-phosphates	370.3	482.4
Tar & benzol	18.2	22.8
Textiles	19.8	21.5
Titanium oxide	97.0	169.2
Unclassified	125.7	144.8
Total	1.552.0	1,901.8

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NEWSLETTER

ISSUED BY

SULPHUR EXPLORATION SYNDICATE
35 PORTLAND PLACE, LONDON, W.1

TELEPHONE: MUSEUM 8497 TELEGRAMS SULFEX, WESDO, LONDON

February, 1954.

ITALY

Following the discussion between representatives of the sulphur industry and the Italian Government, which were referred to in Bulletin No. 3, it is reported that the Italian Ministry of Industry has submitted to the Treasury certain proposals. These concern primarily the financing of unsold sulphur stocks, the accumulation of which resulted from the export crisis which started in the second half of 1952 and has become more serious since then. During the eleven months up to the end of November, 1953, only 6,952 tons were exported against 51,520 tons during the corresponding period of 1952 and an actual export availability of over 130,000 tons. The financing of stocks, which have now reached about ½ million tons, is to assist the Ente Zolfi Italiani, in whose warehouses the material is deposited by the producers.

Another important measure currently under discussion is the closing down of "marginal" mines. This represents an important departure from present practice, under which the payment to producers of an average price based on production costs, encouraged quantitative output from the largest possible number of sources, irrespective of economic factors. Should these two measures be put into effect, a substantial reduction of the price of Italian sulphur is likely to be achieved, although the prices mooted are still in excess of the landed cost of American Frasch sulphur in potential Italian markets.

U.S. SULPHUR PRICES

The following details supplement the information on the change of export prices of U.S. sulphur (bright) reported in Bulletin No. 3. The new export price established by Jefferson Lake Sulphur Co. of $33 per ton is now reported to be applicable in all markets. The new export price charged by Ashcraft-Wilkinson Co. for sulphur produced by the Duval Sulphur and Potash Co. is $31, identical with Texas Gulf Sulphur Co. and Freeport Sulphur Co. and represents an increase of $0 over their previous price. The discounts for dark or off-colour sulphur remain unchanged at $1 for Texas Gulf Sulphur Co. and $0 for Freeport Sulphur Co. and Duval Sulphur and Potash Co. sulphur.

O. E. E. C.

The latest report of the Chemical Products Committee concerns the position of sulphurous raw materials in the sixteen member countries in the first six months of 1953. Comparing this period with the second half of 1952, the report concludes as follows:

Production of sulphurous raw materials, as a whole, remained on about the same level, whereas consumption increased by about the 13%. A comparison of consumption in the First Half of 1953 with that in the corresponding period of 1952 which

in view of the seasonal nature of use in many sectors would be more valid, shows a decrease of about 2%. The following table contains relevant details:-

Thousands Metric Tons

	PRODUCTION			CONSUMPTION				
	2nd Half 1952	1st Half 1953	Change %	1st Half 1952	2nd Half 1952	1st Half 1953	Change % (a)	(b)
Native S.	139.2	117	-16	-	-	-	-	-
Recovered S.	107.9	115.6	+7	-	-	-	-	-
Total S.	247.1	232.6	-6	439.1	296	410.4	-6.5	+38.
Pyrites	818.3	809.1	-0.5	1183.7	1048.1	1149.5	-2.8	+10
Blende	66.9	58.6	-12	179.1	179.2	184.0	+2.8	+2.
Others*	233.0	253.7	+9	238.6	242.8	255.4	+7.1	+5.
TOTAL	1365.3	1354.0	-0.8	2040.5	1766.1	1999.3	-2.0	+13.
Sulphuric Acid	4057.7	4329.1	+6.7	4343.7	3977.3	4380.1	+0.9	+10

(a) Increase/Decrease compared with 1st Half, 1952.
(b) Increase/Decrease compared with 2nd Half, 1952.
*Others include sulphur in spent oxide, anhydrite and mine wastes.

The supply position of the various sulphurous raw materials has deteriorated. In the first half of 1953, consumption and exports exceeded production and imports by about 150,000 tons, whereas, in the first half of 1952, there was a favourable balance of supply of about 180,000 tons and, over the whole year of 1952, a favourable balance of 370,000 tons.

The report does not comment on this change, but this appears to be primarily due to lower imports of sulphur and pyrites during the first half of 1953 at a level of about 34% and 44% respectively below that of 1952.

In view of the large tonnage of Italian sulphur immobilised in producers' warehouses, the reduction of consumers' stocks has been greater than the above figures indicate.

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ITALY

The announcement on 26th July, by the Regional Sulphur Section of the Sicilian Federation of Industrialists, reported by Reuters on 28th July, that all Sicilian Sulphur Mines would close on 20th August, has precipitated the long threatened crisis in the Italian Sulphur Industry.

At first, the Ente Zolfi Italiani intimated that their policy remained unchanged, that in the course of their programme of reorganisation some uneconomic mines may be closed, and that, for political and social reasons - over 60,000 workers in Sicily are directly engaged in the sulphur industry - this programme was being applied slowly and with "considerable prudence". Subsequent events indicate that this view was over optimistic.

On 3rd August, a political delegation from Sicily was received by the Italian Prime Minister, Sgr. Scelba, who is incidentally of Sicilian origin, to whom they presented the case of the sulphur industry, and enlarged on the earlier explanatory communique of the Regional Sulphur Section, which was as follows:-

"The deliberation of the Assembly of the Regional Sulphur Section is the epilogue to a situation which has dragged out far too long. The crisis in the sulphur industry has touched rock bottom with the weakening of the financial resources of the mining firms, which owing to the insufficiency of the advances against the Warehouse Warrants, find themselves in the material impossibility to meet workers' wages. It is not the decision itself that should cause surprise because, little by little, each single mine would have been compelled to close down, as much as the seriousness of the causes which have determined it. Everyone knows what these reasons are. The Assembly of the Regional Sulphur Section, conscious of its responsibilities, feels that it is its duty to give notice in advance of an extremely painful nature and consequence, of which it has repeatedly given warning and which is, absolutely, not attributable to the will of the mineowners who have sacrificed themselves to the limit of their possibilities to defer this decision, in the hope that the responsible central authority would have given effect to its assurance of an adequate intervention."

the Region globally in order to meet the requirements of those mines which are desirous of benefiting by the provisions of the law, and have been precluded from doing so by the need of a bank guarantee. In addition, a further two billion lire is to be set aside for the renewal of plant and machinery.

A second Bill provides for the financing of Sicilian mines, limited to working expenses during the entire period of reactivation, to those firms who have effected alterations to their plant. Advances may be refunded in ten to fifteen years up to a maximum sum of 150 million lire to those mines which, starting before January, 1953, are in the process of installing new plant for enriching the ore for flotation, and which are working ore with a smelted yield lower than 9%. The aliquot for amortisation is permissible up to 600-700 lire per ton.

The third measure concerns the problem of accumulated stocks which, at present, amount to about 250,000 tons, or at about the same level which was reached before the conflict in Korea. This measure accepts the principle of aid to producers, but in what form had still to be established by the Interministerial Committee for Reconstruction. Two solutions have been mooted; to pay interest on the basis of the price at time of delivery until market prospects improved, or to sell the stock at international prices and charge the loss to the State budget. In the first instance the budget would have to meet about two billion lire (£1⅛ m.), and in the second some three and a half billion lire (£2 m.).

In the meantime, the Sicilian Labour Unions have instructed the sulphur workers to oppose the mine owners' threatened lock-out and to continue mining operations.

It is evident that the whole question has now passed beyond the competence of the E.Z.I., who have started the new trading year on 1st August, 1954, under the direction of a new board under the chairmanship of Dott. Ing. Francesco Lanza di Scalea.

The grave economic difficulties of the industry are now accompanied by even more serious political and social complexities.

5th August 1954.

It is further understood that three measures revoking existing laws, which the Minister of Industry had earlier submitted to the Interministerial Committee for Reconstruction for consideration at the next meeting, may now be tabled in the Legislative Assembly, after the summer recess.

The first proposes the integration of the nine billion lire already earmarked for the financing of those mines who intend to modernise their installations, and accepts, almost totally, the demands of the industry. The Law of the 12th August, 1951, n. 748, which regulates the concession loans is likely to be modified so that the guarantee will be given by (continued)